→ Effect Assessment of Nano- and Microplastics in Freshwater Ecosystems

TRAMP Technologies for the Risk Assessment of MicroPlastics

Paula E. Redondo Hasselerharm

Promotor: Prof. Dr. Albert A. Koelmans
Co-promotor: Dr. Edwin T.H.M. Peeters

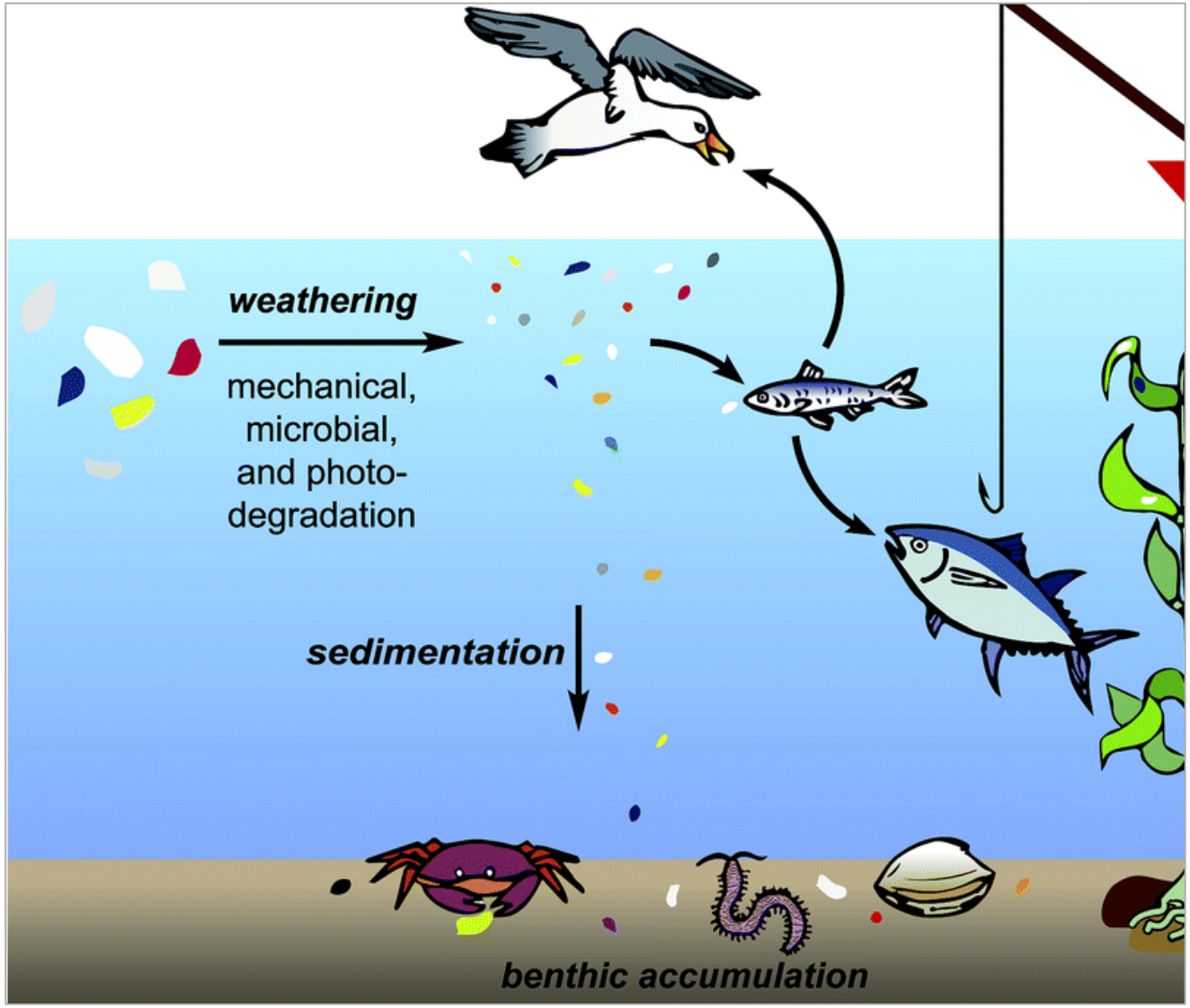
Aquatic Ecology and Water Quality Management,
Wageningen University & Research

WAGENINGEN UNIVERSITY & RESEARCH

INTRODUCTION AND OBJECTIVES

INTRODUCTION: Potential Risks of Microplastics

INTRODUCTION: Sediments as Sinks for Microplastics



Source: Lin (2016)

Freshwater sediments act as a sink for MP

↓

600-fold higher MP concentrations in sediments compared to the water phase (in particles/m^3) in the Elbe river (Scherer *et al.*, 2020)

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Freshwater benthic organisms could be exposed to high MP concentrations

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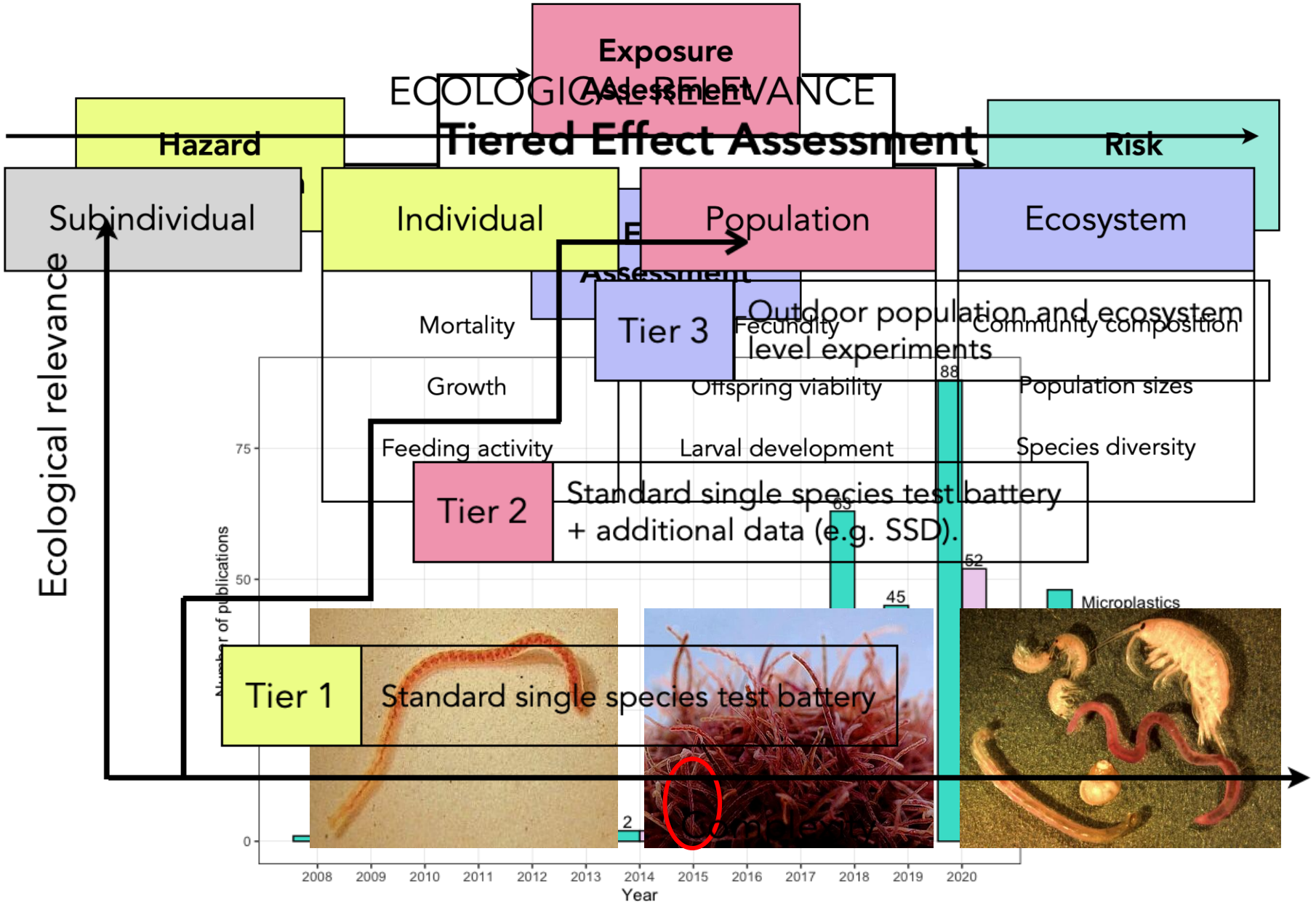
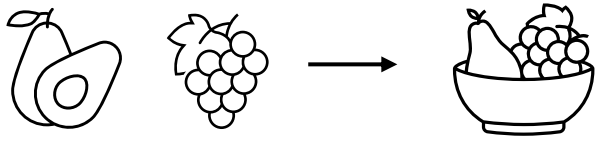
Risks of MPs never assessed for freshwater benthic organisms exposed via sediment

INTRODUCTION: Effect Assessment of Microplastics

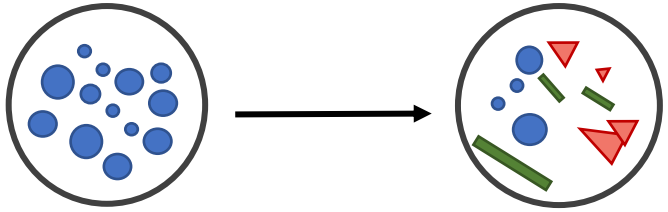


INTRODUCTION: Limitations in Environmental Risk Assessment of Microplastics

- **Exposure and effect data are not comparable**

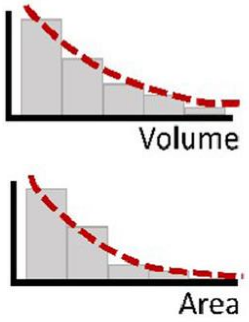


- **Effect data are not ecologically relevant and do not consider effect mechanisms**

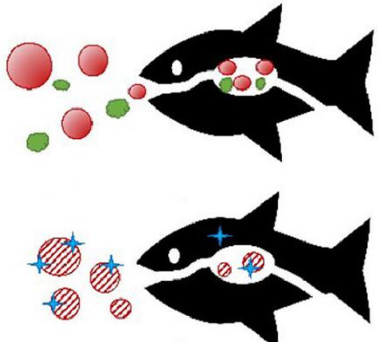


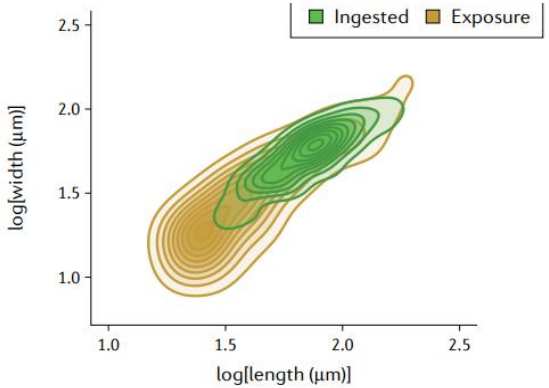
Monodisperse MPs

Polydisperse MPs



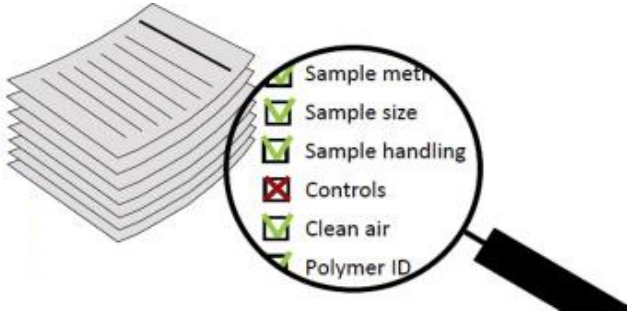
Effect mechanisms





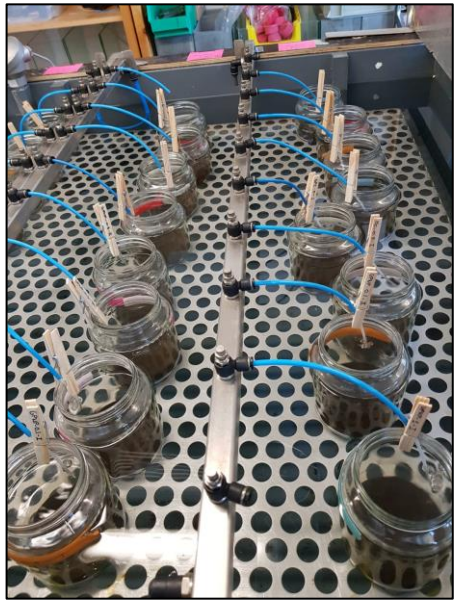
Bioaccesible fraction

- **The quality of the exposure and effect data has been questioned**

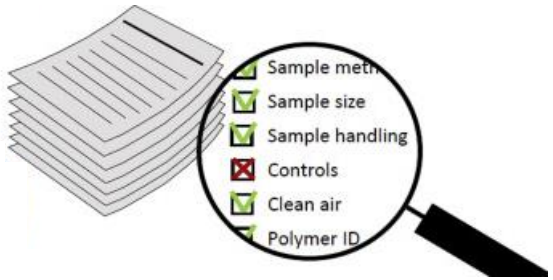


OBJECTIVES

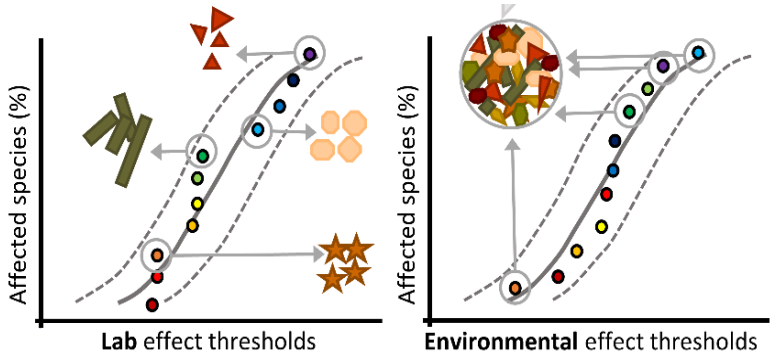
- Effect thresholds for freshwater benthic species exposed to NMPs
- Quality Assurance/Quality Control (QA/QC) tool for effect tests
- Mechanisms behind the effects of NMPs
- Assess the risks of MPs in freshwater benthic ecosystems



QA/QC screening tool

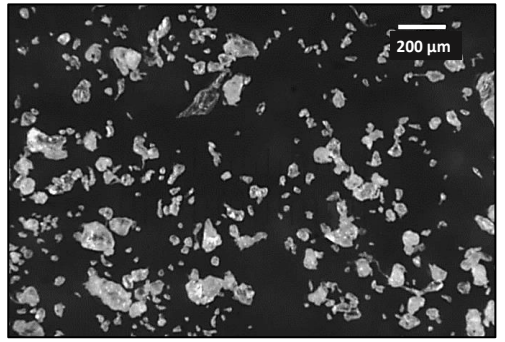


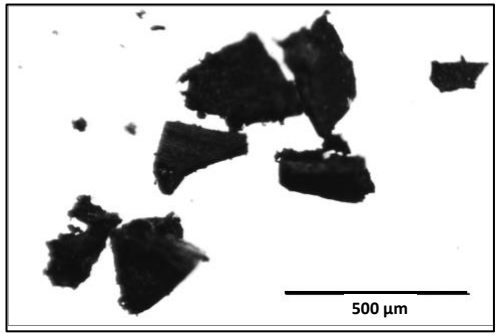
Alignment methods

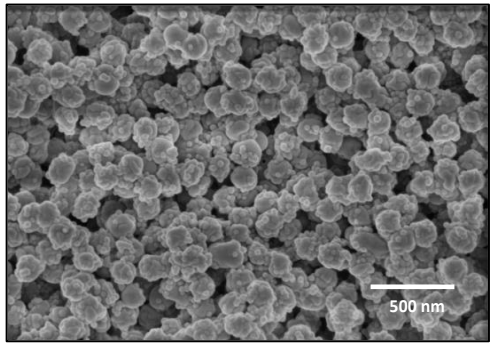


METHODS

METHODS: Chronic Effects and Uptake of Nano- and Microplastics on Single Species

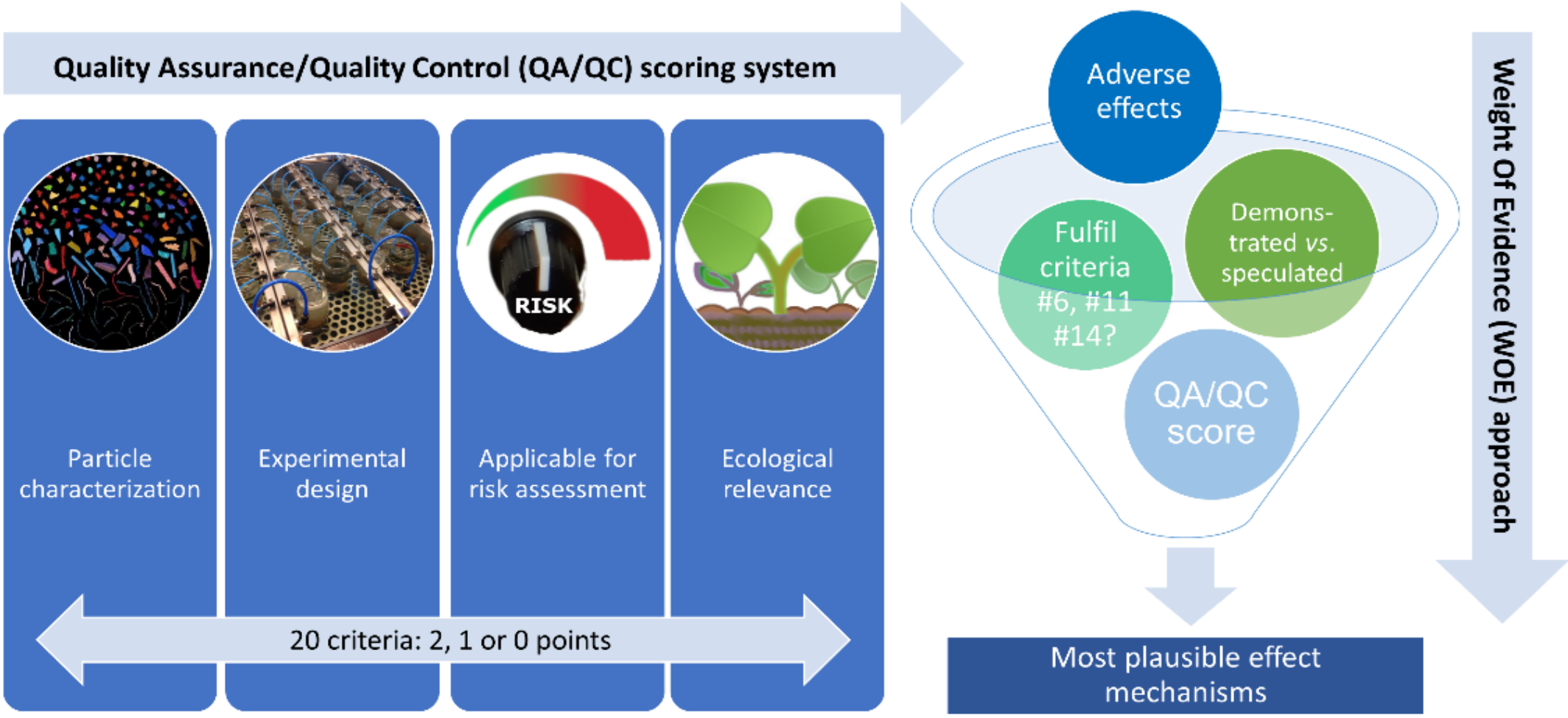






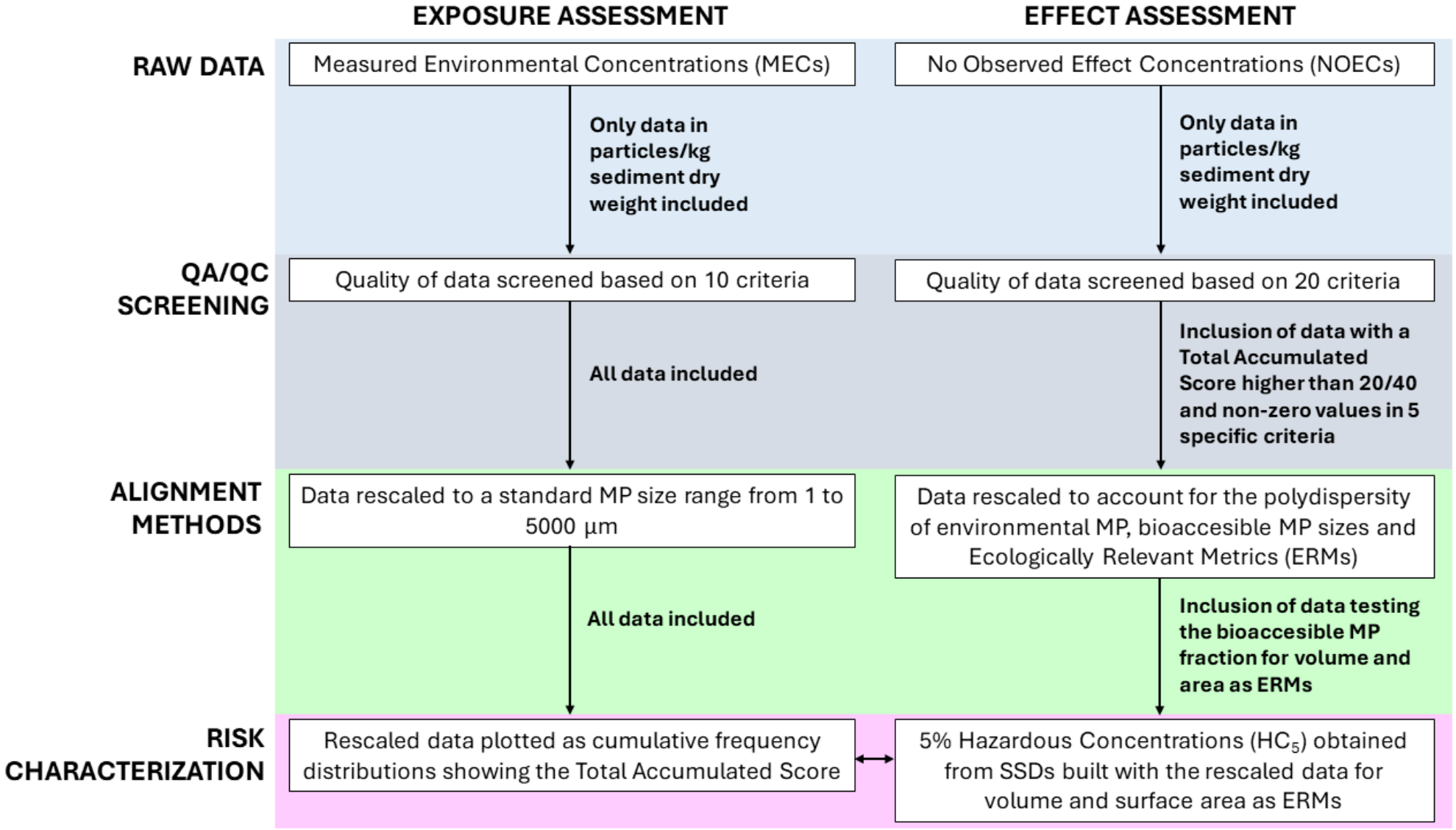
METHODS: Long-term Community Effects of Nano- and Microplastics

METHODS: QA/QC Scoring System and Identification of Effect Mechanisms



Source: De Ruijer, Redondo-Hasselerharm *et al.* (2020)

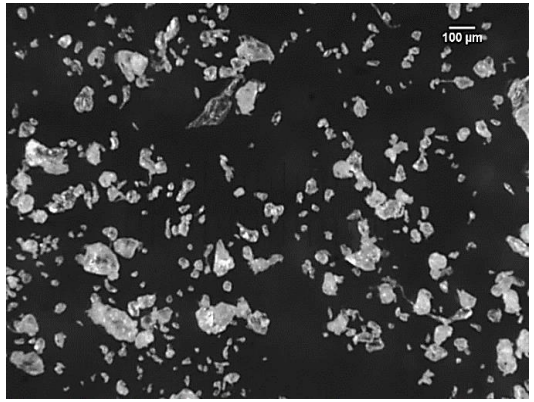
METHODS: Environmental Risk Assessment

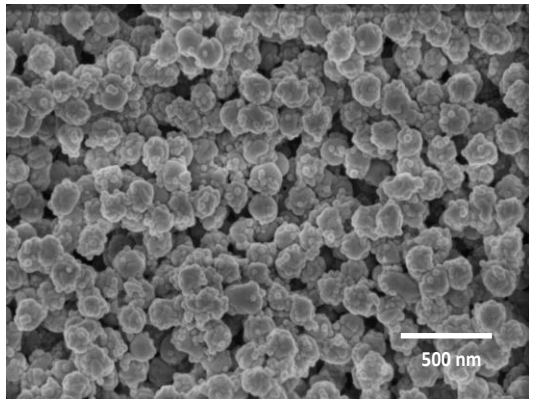


Source: Redondo-Hasselerharm *et al.* (2023)

RESULTS

RESULTS: Effects and ingestion of NMPs on individual organisms



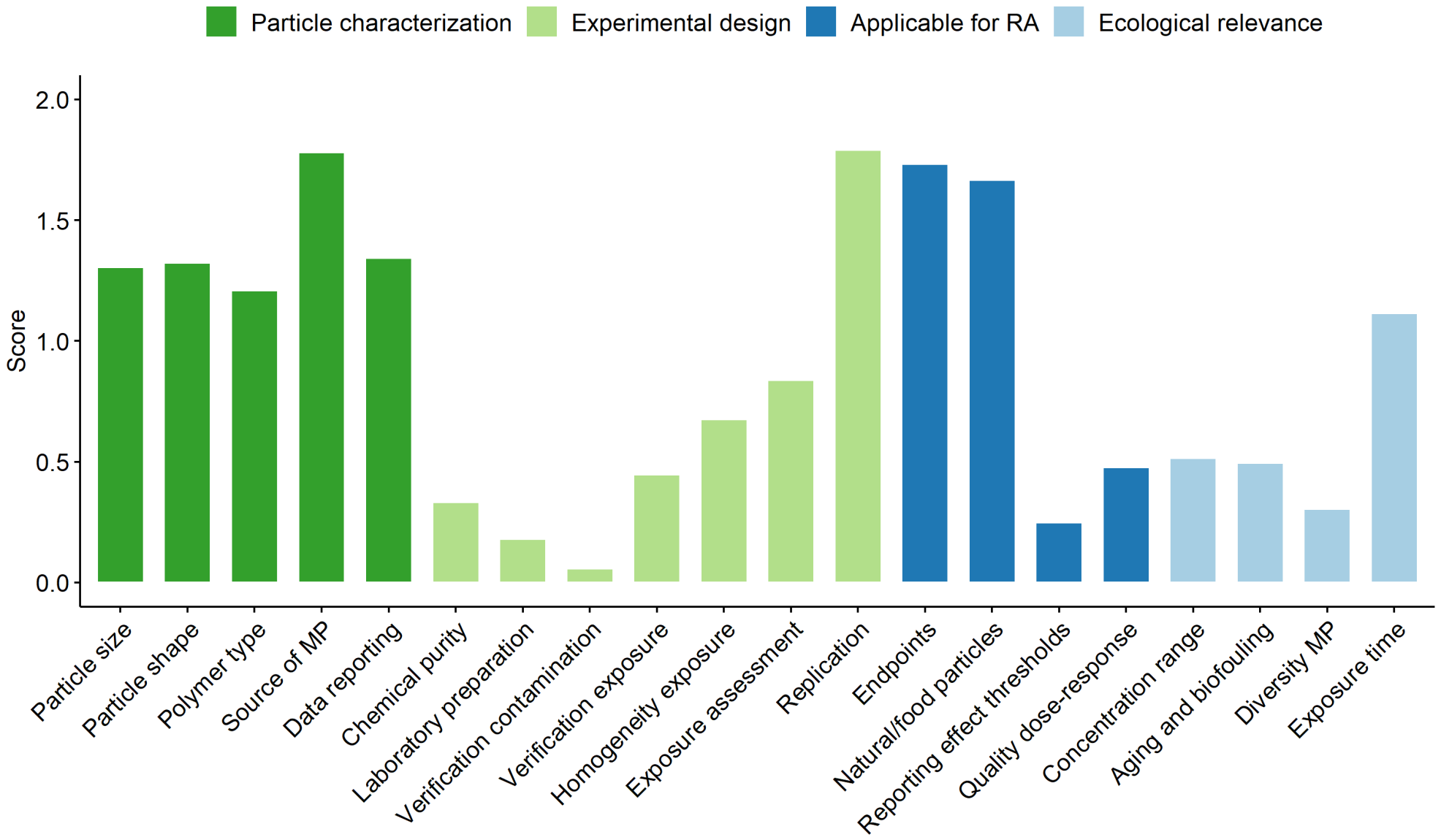


- Growth of *Gammarus pullex* affected by polystyrene MP
- *Gammarus pullex* was not affected by other NMP and no other organism was affected by any of the NMP
- Proportional ingestion by *Gammarus pullex* for all NMPs
- Larger volume of MPs found in the body compared to NPs

	Polystyrene Nanoplastic	Polystyrene Microplastic	Unit
Trophic Transfer Factor Sediment → Body	0.020	0.092	[mg/kg organism] / [mg/kg sediment]
Trophic Transfer Factor Sediment → Gut	0.031	0.025	[mg/kg organism] / [mg/kg sediment]
Trophic Transfer Factor Sediment → Total organism	0.051	0.116	[mg/kg organism] / [mg/kg sediment]
Percentage in body	39.8	78.7	%
Percentage in gut	60.2	21.3	%

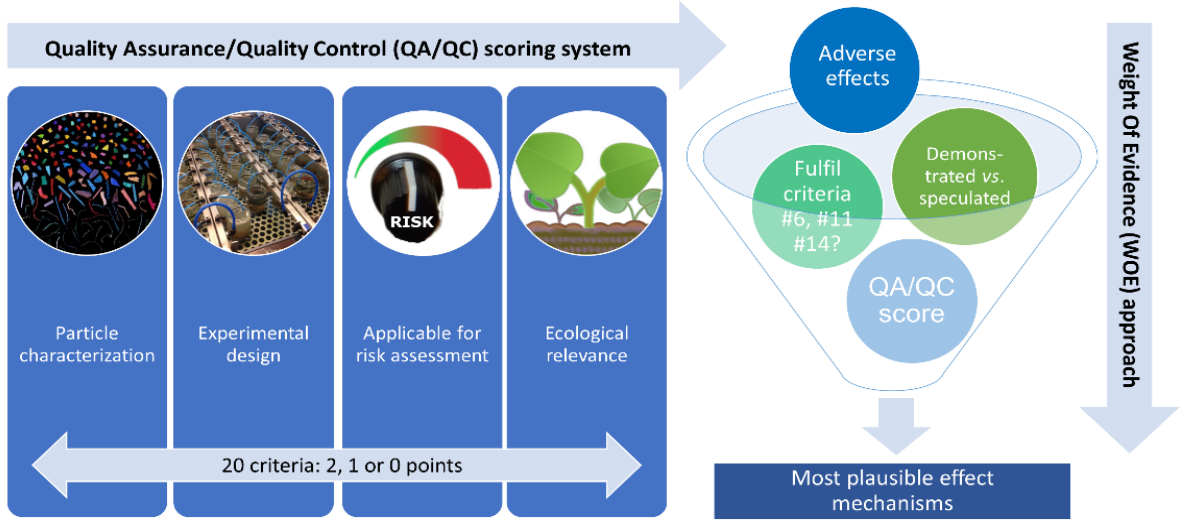
Sources: Redondo-Hasselerharm *et al.* (2018, 2021)

RESULTS: QA/QC applied to 105 effect studies



Source: De Ruijer, Redondo-Hasselerharm *et al.* (2020)

RESULTS: Identification of effect mechanisms

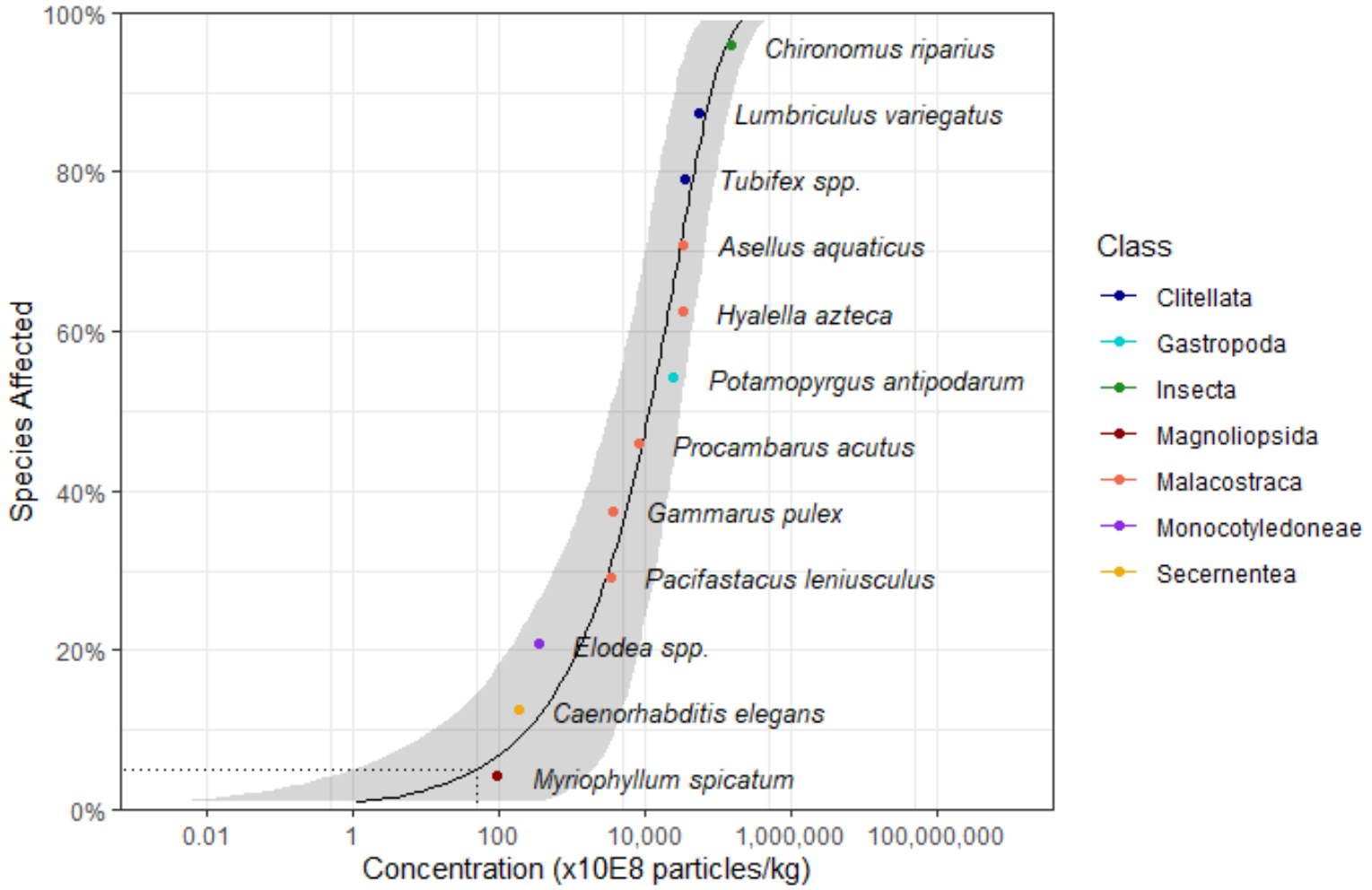


no.	description of mechanism explaining adverse effect	suggested[a]	demonstrated[b]	number of studies that fulfill criteria nos 6, 11, and 14[c]	average score of studies that fulfill criteria nos. 6, 11, and 14 QA/QC[d]
1	inhibited food assimilation and/or decreased nutritional value	32	9	5	21.4
2	internal physical damage	20	7	3	21.0
3	external physical damage	8	4	2	24.0
4	oxidative stress	6	8	1	16.0
5	disturbance of essential processes that affect physiology	8	3	0	
6	adjustment of energy metabolism to cope with mp	1	2	0	
7	microbial imbalance	2	1	0	
8	leaching additives or chemicals	14	0		
9	(cellular) stress	8	0		
10	effects of surface properties	2	0		
	total	100	34	11	

Source: De Ruijer, Redondo-Hasselerharm *et al.* (2020)

RESULTS: Species Sensitivity Distribution (SSD) rescaled based on volume

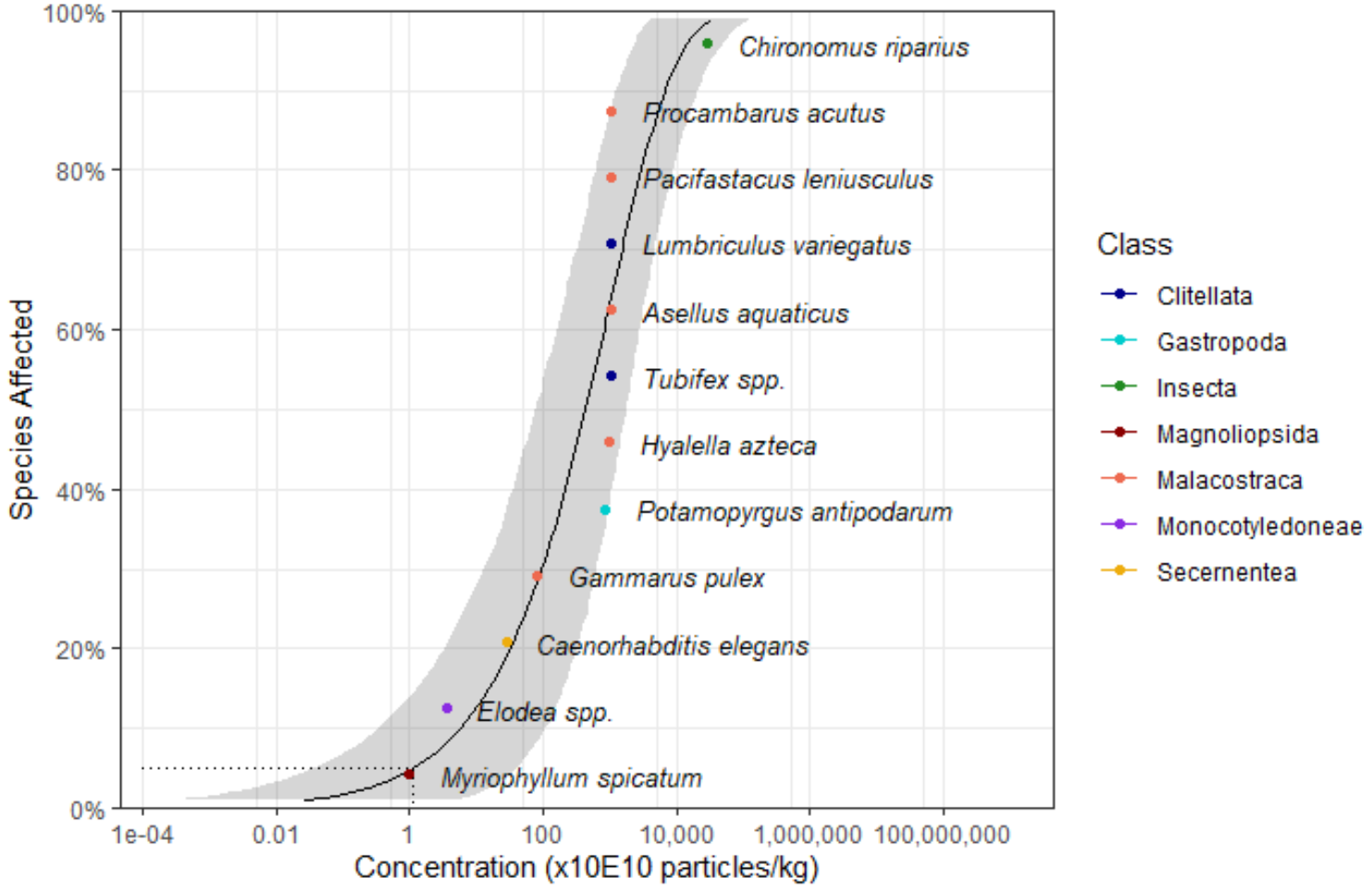
HC_5 volume = 4.9×10^9 particles / kg sediment dry weight



Source: Redondo-Hasselerharm *et al.* (2023)

RESULTS: Species Sensitivity Distribution (SSD) rescaled based on area

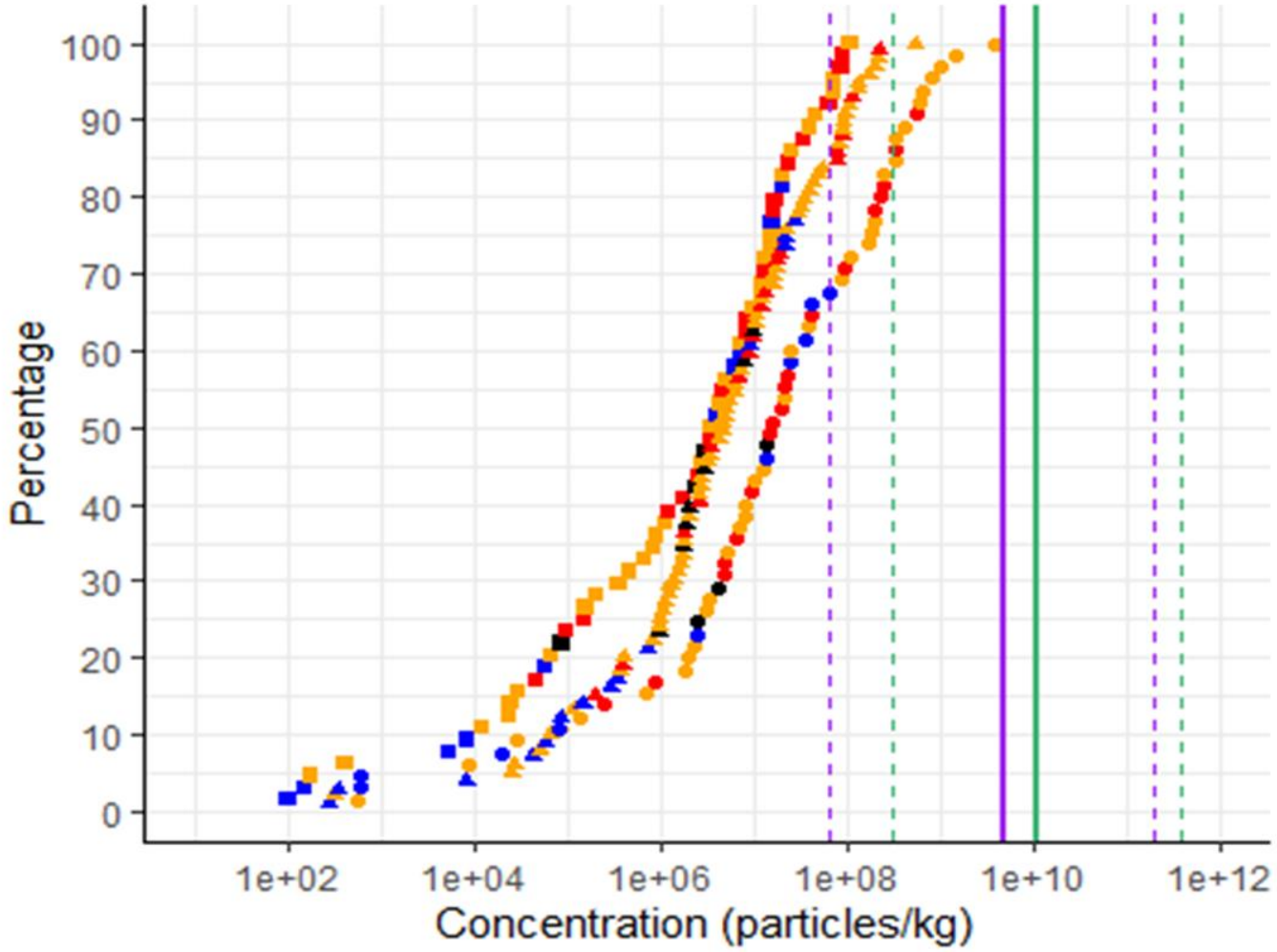
HC_5 area = 1.1×10^{10} particles / kg sediment dry weight



Source: Redondo-Hasselerharm *et al.* (2023)

RESULTS: Risk Characterization

Low confidence limit for volume and area exceeded by 32% and 17% of the maximum MECs



Measured Environmental Concentrations (MECs)

- Minimum
- Mean
- Maximum

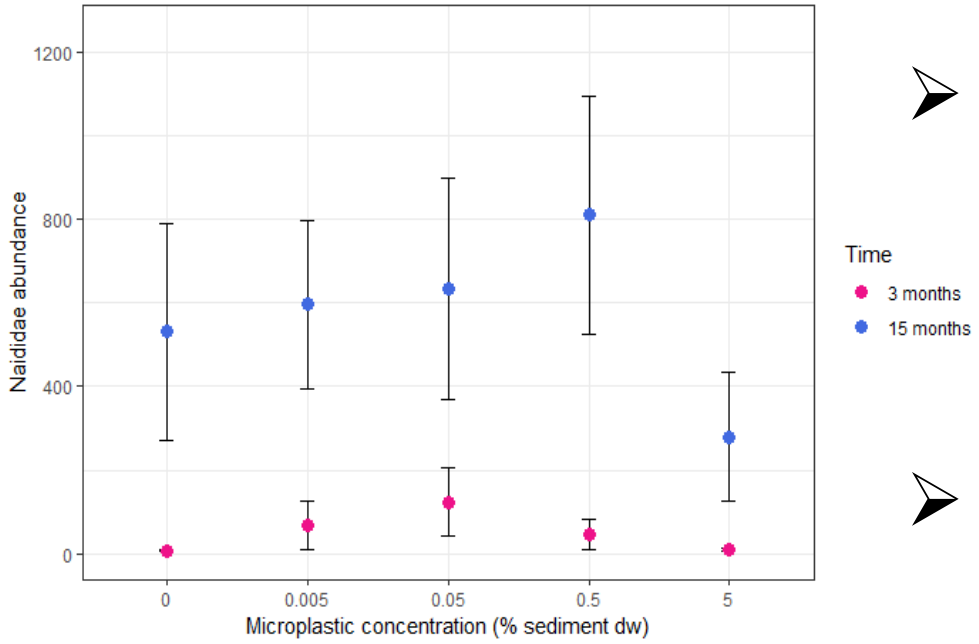
Total Accumulated Score

- ≥ 16
- 11 ≥ 15
- 6 ≤ 10
- ≤ 5

HC_5 (95% CI) for volume (food dilution)

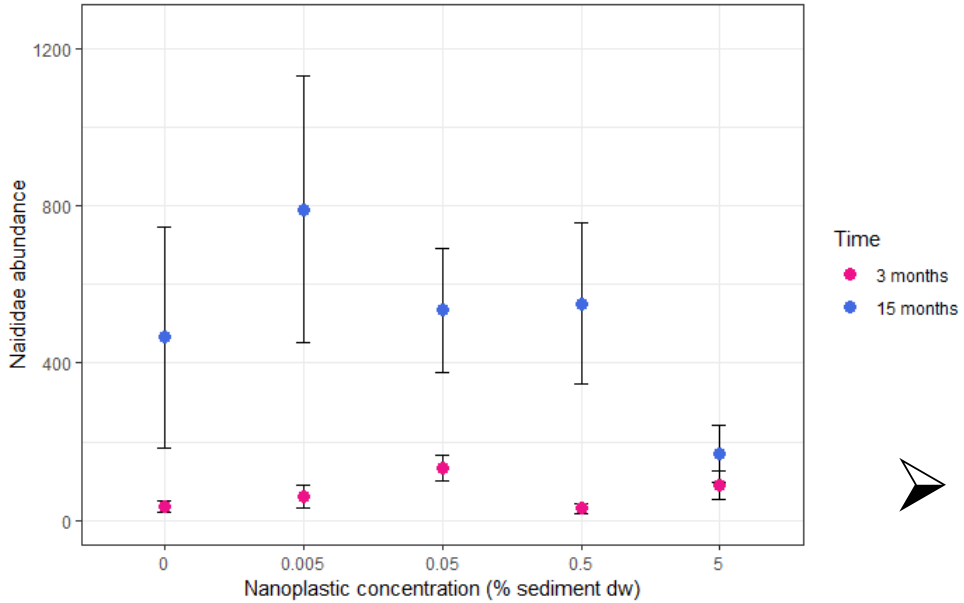
HC_5 (95% CI) for area (translocation)

RESULTS: Effects of NMPs on a Benthic Community



➤ **Effects of NMPs on the community composition after 15 months**

➤ **This was caused by a reduction in the number of Naididae worms**



➤ **Effect thresholds were higher than MECs in freshwater sediments**

CONCLUSIONS

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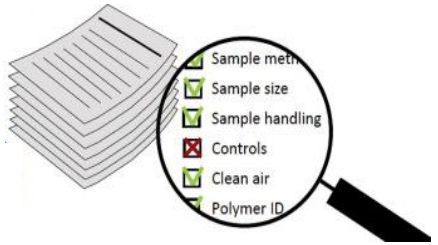
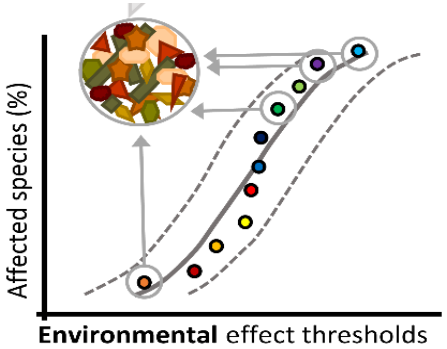
- No risks of MPs for freshwater benthic species using strict quality criteria and data alignment





The HC_5 lower confidence limit for volume and area exceeded by 32% and 17% of the maximum MECs

- Quality of studies should improve, and data on effects and mechanisms needed to refine the ERA

- Long term effects found on benthic community composition, at concentrations higher than MECs

THANK YOU FOR YOUR ATTENTION!

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